

Physics Division Future Plans

Jim Siegrist

**Director's Annual Review
November 10 & 11, 2004**

Summary of Progress



- Important technical progress on SNAP R&D, particularly in the sensor area
- Improved understanding of DOE/NASA relationship & LBNL role, moon-Mars impact on NASA under assessment
- Supernova Factory commissioned this year
- ATLAS silicon-strip tracker completed
- ATLAS pixel tracker in production
- ATLAS Data Challenge happening this year
- Run II CDF physics hitting full steam
- BaBar physics at full steam
- CMB work breaking new ground in instrumentation
- θ_{13} neutrino effort showing promise
- Theory: EWSB, CKM, extra dimensions, particle astrophysics, strings...
- PDG printed next book

Exciting activity at every turn

Our highest scientific priorities in the longer term are:

- 1. Electroweak Symmetry Breaking
(LHC, LC)**
- 2. Dark Energy in the Universe
(SN/SNAP, CMB)**
- 3. A modest neutrino program, joint with NSD featuring KamLAND and a reactor-based θ_{13} measurement**

Active Proposals

Recent Proposal Progress



- SNAP has enjoyed extensive review & prioritization by the community. Scope of necessary R&D is clear; we propose 3-year R&D profile.
- Supernova Factory work reviewed internally at end of October –
— Very positive review; much progress evident
- ATLAS has been under continual project review since inception.
- CDF & BaBar at LBNL have finite remaining lifetimes with clear physics objectives.
- CMB work currently lacks full community endorsement. Our proposal to vet this work was well received by SAGENAP. Now need the endorsement of the CMB working group to proceed to R&D funding.
- θ_{13} neutrino experiment just at the inception. Have submitted an NSF proposal for R&D support, plan to submit soon to DOE.

Linear Collider



- **We expect to play a significant role in LC R&D as international program ramps up**
- **Battaglia is establishing R&D program for LC supported by LDRD**
- **Kolomensky active on beam instrumentation**
- **Ronan making major contributions to detector R&D, especially TPC**
- **With the technology decision in hand and support from the LDRD, our effort will grow**
- **LBNL offered to host the Center for the Global Design Initiative**
- **AFRD concentrating on damping ring design**

DOE requested we provide a list of future initiatives. We argued:



- **We have moved our efforts to support the best science**
- **Investments in LBNL funding can help us help you to move the community to the best science**

Initiatives (1): New Experiments



- We are developing two new proposals for science
 - POLARBEAR
 - Reactor Experiment to Measure θ_{13}
- We cannot accommodate those proposals within our current budget
- We are working with the university community to build strong collaborations

- **Motivation**
 - Detect the B-mode polarization of the CMB, a signal of gravity waves from Inflation
- **Proposal**
 - To be submitted in December 2004
- **Science validation:**

CMB science has been given the highest priority by the community. CMB Polarization observation, in particular, is the first of seven recommended areas in the NSF/DOE/NASA panel report “Connecting Quarks with the Cosmos.” They recommend: “Measure the polarization of the cosmic microwave background with the goal of detecting the signature of Inflation. The committee recommends that NASA, NSF, and DOE undertake research and development to bring the needed experiments to fruition.” The DOE/NSF subpanel on long range planning for U.S. High-Energy Physics (Bagger-Barish report) recommends: “The quest to understand the origins of dark energy and dark matter are important components of a broader program of cosmological measurements, including studies of the cosmic microwave background radiation and the large-scale structure of the Universe. Particle physicists are involved in this broad program through a variety of experimental efforts. We expect that this effort will continue to grow during the next decade.” NASA has responded to community recommendations by putting the CMBPOL satellite on their roadmap of Einstein Probes along with JDEM.

- **What reviewers say:**

Unfortunately, the level of support that LBNL can continue to provide is declining because of the slow but steady erosion of the LBNL high energy physics budget. While the group can meet its existing commitments, it is unlikely that they can step up to the competition for the next major thrust in CMB observations without a significant increase in support.

The Polar Bear experiments proposed by the LBNL-Berkeley group will provide more detail on the reionization epoch and should be able to measure the B modes caused by gravitational lensing before they reach the greater sensitivity required to detect inflation-generated B modes.

*We note that, while LDRD funding (which was denied last year) could relieve their burden in the coming year, the Laboratory's role in the CMB cannot be more significant unless additional funding for this activity from the DOE Office of Science can be found (see further discussion at the end of section 6). **This is a tragedy, because this line of research could produce results as profound as the Dark Energy discovery made by the Supernova team.***

Reactor Experiment to Measure θ_{13}



- **Motivation:**
 - A precision experiment to measure the mixing angle θ_{13}
- **Proposal:**
 - In preparation. To be submitted in December 2004
- **Science Validation:**

The importance of a θ_{13} measurement has been evaluated by a number of committees and review panels and is also evident in the number of publications on this topic. In 2003/2004 over 20 papers were published on the measurement of θ_{13} with reactor neutrinos and its implications for neutrino physics. A White Paper Report with over 100 authors published in January 2004 summarizes the community's effort and interest in this measurement [1].

A precision reactor neutrino measurement to measure θ_{13} is included as a near-term priority in the preliminary recommendations of the APS Neutrino Study that were discussed at Snowmass in July 2004 [2]:

"A comprehensive program to attack the coupled problem of the θ_{13} , mass hierarchy and CP violating phase δ should include a reactor experiment with a sensitivity of 0.01 for $\sin^2 2\theta_{13}$ and a long-baseline accelerator experiment sensitive to the hierarchy through matter enhancement."

In the recent report "Quantum Universe" the DOE/NSF High Energy Physics Advisory Panel and the Quantum Universe Committee state:

"...dedicated reactor neutrino experiments may tell us if a measurement of CP violation in the neutrino sector is feasible. Then researchers might use a neutrino superbeam or neutrino factory to search for it" [3].

The report of the HEPAP Facilities Committee "High-Energy Physics Facilities on the DOE Office of Science Twenty Year Roadmap" from March 2003 emphasizes that

The observation of oscillations of one type of neutrino into another and the implication that neutrinos have non-zero masses have been major discoveries of the past few years". The HEPAP committee finds that "The measurement [of θ_{13}] has important scientific potential" [4].

- **What reviewers say:**

In the report “Neutrino Science at LBNL: Present Program and Future Options” presented to the General Sciences in April 2003 the LBNL Neutrino Working Group concluded that the

“Search for θ_{13} is the most important experiment for determining the future direction of neutrino physics. LBNL should pursue this option vigorously with the goal of leading a US experiment”

From Director’s Review, Nov 03:

“The proposed experiment is very exciting from both the physics point of view, as the value of θ_{13} is one of the major remaining mysteries in neutrino physics, and from the detector point of view, since it is technically feasible with existing technology. Due to the need for major civil construction, it will not be a minor undertaking, however the physics payoff is large and we concur with the Lab Director in strongly supporting this effort.”

Initiatives (2): Proposals to Support the Community



- **Grid Security**
 - Workshop being planned with ESnet & Fermilab
- **Detector Center**
 - Will build on existing university collaborations
 - Detectors for SLHC and LC
 - Superconducting detectors for CMB and Dark Matter
- **Quantum Universe Institute**
 - Support Cosmology program in the HEP community
 - Emphasize workshops/visitors to enhance university program and bridge particle physics and cosmology

Near Term Issues

Near term science for LBNL:

Dark Energy studies – Supernova Factory

APEX/SZ

Flavor Physics – BaBar, CDF, KamLAND

Electroweak Parameters – CDF, ATLAS

In Development:

ATLAS upgrade, SNAP, CMB Polarization (Polar Bear), θ_{13}

Near term priorities: Keep developments on schedule, harvest physics from past investments.

Actions to Accommodate FY04 Budget



- **Allocated resources to high priorities in accordance with strategic plan and review recommendations:**
 - **CDF, D0 into ATLAS; BaBar into Dark Energy**
- **Accelerate reduction in postdocs for lower priority efforts and bring in needed staff for high priorities**
- **Reduce non-labor allocations for all programs, especially lower priorities**
- **Protect SNAP funding to the extent possible**

Note: about 7% of our budget is available for M&S and travel

FY04 Program Impacts



- **Severe reductions of travel & purchases**
- **Continue planned net manpower reductions (CDF, BaBar)**
- **Delay engineering work on CMB, neutrinos**
- **Delay planned ATLAS manpower increases**
- **Consolidate proton collider (ATLAS, CDF, D0) research under Gilchriese**

A very tough year.

Longer Term Plans



Longer term science for LBNL:

What is Dark Energy? - Hi Z surveys

What are the origins of mass? – ATLAS

What powers inflation? – PolarBear

Is CP violation observable in the neutrino sector? - θ_{13}

In Development:

SNAP, LC, CMB polarization satellite, ...?

Problem Areas



- **Restore Theory at LBNL (~done)**
- **Prepare for ATLAS physics**
- **Enhance Cosmology Theory**
- **Maintain Supernova Science Program**
- **Strengthen Neutrino projects**
- **Support Linear Collider R&D**
- **Slow our withdrawal from the BaBar physics program**
- **Slow our withdrawal from the CDF physics program**

Future Planning



Need to balance in the long run allocations among:

- **Staff salaries and wages**
- **Operations costs**
 - Travel
 - Purchases
 - Recharges (space, phone, etc.)
- **Reinvestment in staff and infrastructure**

Budgetary Outlook



- **Significant increase FY03 to FY04 to support SNAP R&D but some was at the expense of other parts of our program (~10% reduction)**
- **Increased scope-of-work has strained our resources significantly**
- **In order to support hiring new staff into high-priority programs we have reduced staff elsewhere**
- **We are reducing research efforts across the division to match funding**

Recent Appointments



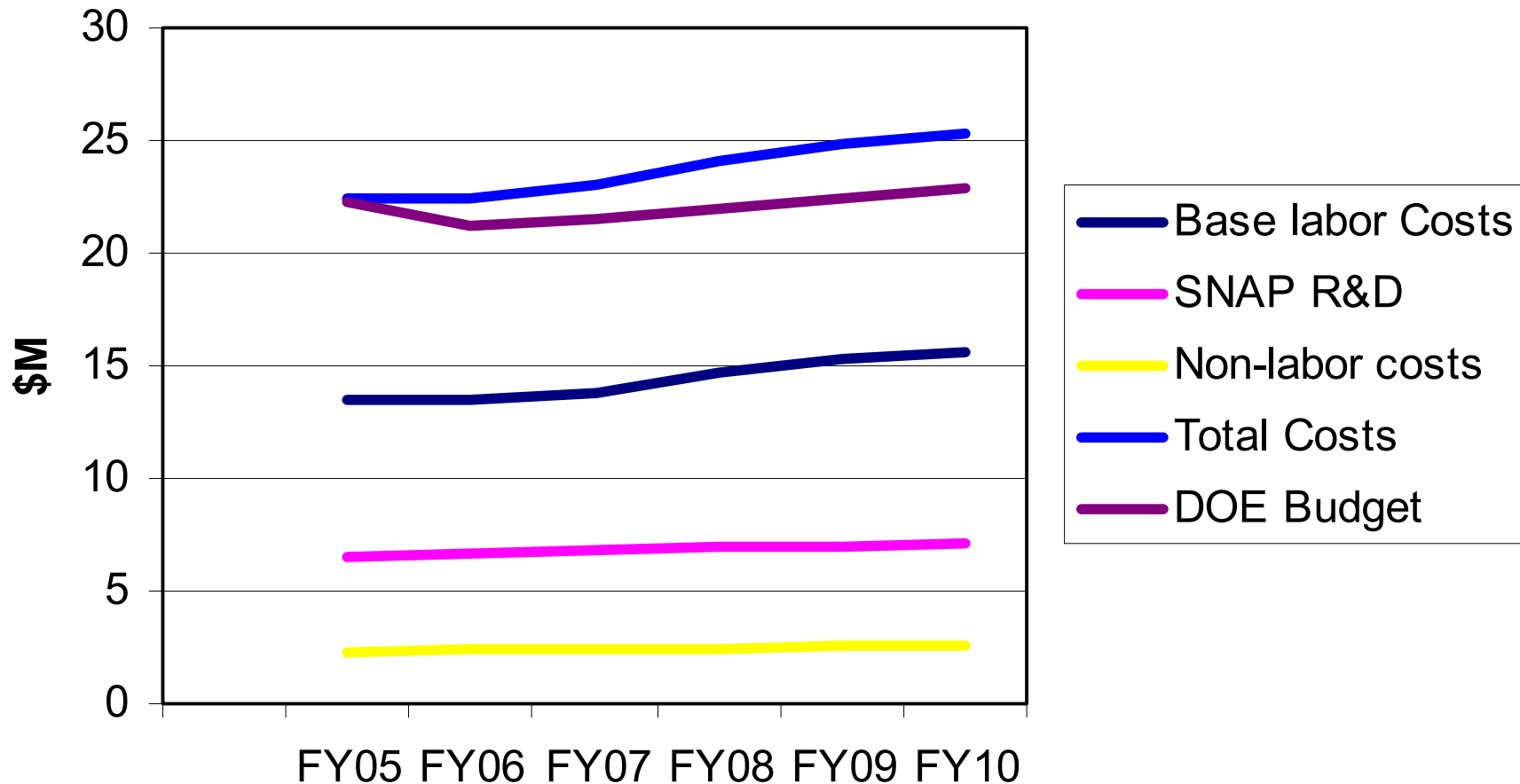
- **First Division Fellow in Cosmology:**
 - David Schlegel from SDSS
- **Campus Theorists:**
 - Bousso
 - Nomura
 - Aganagic
- **New postdocs in ATLAS, Supernova Cosmology and SNAP**

Searches Underway



- **Division Fellows**
 - ATLAS
 - Theory
- **Chamberlain Fellow**
- **Postdocs**
 - SNAP
 - ATLAS
 - BaBar
 - Neutrino LDRD
 - Linear Collider LDRD

Physics Division Budget Reality



Quality of Our Program Remains Very High



Statements of support –

•R. Staffin from February 2004 DOE Review

•*“LBNL is the best in the world in:*

•*Dark Energy*

•*Semiconductor detectors (both particle and light detectors)*

•*High-field magnets [AFRD]*

•*Particle data group, education and outreach*

•*LBNL is as good as the best in the world in:*

•*Collider physics analysis and computing”*

•R. Staffin from May 2003 DOE Review

—*“The overall evaluation is that LBNL is performing outstanding work with a strong emphasis on many of the important areas of high energy physics. The DOE HEP budget continues to be quite tight, and we recognize that has a significant impact on LBNL program. I want to work with you to find ways of continuing LBNL’s excellence in these challenging times.”*

•From November 2003 Director’s Review

“The committee was very impressed with the Division’s current physics program and past achievements and rates the program as outstanding. The Physics Division has a proud tradition of technical innovation and of intellectual leadership on the projects it has engaged in. It maintains a position of leadership and importance in the U.S. high energy physics program, and its plans are appropriately aligned with accepted national priorities (as stated, e.g., in the HEPAP subpanel and DOE Facilities reports).”

Summary



- **LBNL has helped shape HEP in the US over the past decade.**
- **We have established and continue a record of innovation and achievement.**
- **We are positioned to have a major impact on ATLAS and Supernova Science and are exploring smaller projects with great science potential**